

# PATENT SPECIFICATION

694,058



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## COMPLETE SPECIFICATION

### Improvements in and relating to Loud Speakers

I, HENRY REGINALD MILNES, a British Subject, of "Seacraig", Tay Street, Newport, Dundee, Angus, Scotland, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to loud speakers. It is already well appreciated that the coil of a loud speaker should be as light as possible and that it should work in an intense magnetic field. The coil is, therefore, usually wound on a paper cylinder, as the wire of the coil alone would not be self-supporting, and it is stiffened as by varnishing. The coil is arranged to work in an annular gap between a central pole and the surrounding outer pole or ring of a permanent or electro-magnetic magnet and this gap, which is made as small as possible, has to accommodate the wire of the coil and also the thickness of the paper.

The paper cylinder constitutes quite an appreciable mass which serves no other useful purpose than to transmit the movements of the coil to the cone either directly or by means of a spider, the cylinder or coil engaging portions of which may be accommodated in slots in a magnet pole.

Now the principal object of the present invention is to provide a loud speaker having a coil former which will effectively support the coil in a narrow magnetic gap, in an arrangement in which the former will vibrate in response to as well as transmit the movements of coil to the cone such that frequencies in the lower ranges are carried direct to the cone whilst those in the higher ranges resonate the former, with a view to obtaining a more exact reproduction of the applied signal.

To this end according to the present invention, the central pole of the magnet is a multi-faced prism having a groove at each angle between adjacent flat surfaces and a light single layer coil is supported

in the magnetic gap by the cranked ends of arms radiating from a central hub or boss of light weight material which cranked ends work in the grooves in the central pole while the arms form a resilient connection to the cone. Thus in this arrangement the magnet gap need be no wider than sufficient to accommodate the coil which should be made as light and as thin as possible, e.g. a thin metallic ribbon of one or more turns or a very thin metal wire coil. The greater flux density in the narrower gap more than compensates for any local reduction which might occur where the grooves are formed in the central pole, although the lowered induction obtained by using a shorter coil offsets any such reduction.

The radiating arms resonate in response to high frequencies and react on the cone of the loud speaker much in the manner of a tuning fork which when vibrating emits sound, which is more clearly audible when the bottom of the fork is placed in contact with a hard object or a resonator. These arms also form the resilient connection between the coil and the cone.

The material of the coil whether it be ribbon, foil, or wire, might vibrate sideways intermediate its points of support, and, furthermore, due to the heat generated, there may be some expansion of the coil which might result in its slackening. Each of these possible disadvantages are avoided, in accordance with a still further feature of the invention, according to which the coil is damped by the ends of further arms which bear thereon intermediate the cranked arms, these further arms working in grooves in the flat faces of the central pole or in the outer ring of the magnet. These further arms may form part of the element connected to the cone.

Desirably, these further arms resiliently bear on the coil under light tension to hold the same firm, even on the occurrence of some expansion due to temperature rise under working conditions, and they are

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furthermore adhered to the coil as by varnish.

The coil former may be made in a variety of ways, either as a unit consisting primarily of a number of radially extending regularly spaced arms which extend laterally and are bent to receive the coil, or some of which are bent to receive the coil and then the other intermediate arms bent down to bear on such coil.

Alternatively, the coil former may be made as two parts, with similar radiating arms having laterally extending or bent ends, when the ends of the arms of the one member support the conductor and those of the arms of the other, when the two parts assembled, bear on such coil.

The coil former may be machined from the solid or fabricated by securing appropriate arms to a central boss with or without the use of a ring situated intermediate the length of the arms.

The coil former is made of the lightest possible material, preferably a magnesium alloy but an aluminium alloy could also be employed, or even a plastic material of adequate strength.

In effect, only the ends of the cranked arms and of the damping arms form part of the weight of the coil, whilst the remainder of the arms and the centre portion of the device form part of the weight of the cone.

The coil former may be connected to the neck at the apex of an orthodox loud speaker cone, as by connecting such neck to the ring of the coil former, but it is preferred that the cone be truly conical or its conical shape completed by a light weight cone when the real apex of such a truly conical cone or added light cone is connected to the centre of the coil former irrespective of whether or not it is formed with a ring.

The coil is centralised by a suitable spider, but it is also preferred to assist such centralisation by means of a plurality, comprising at least three cords of nylon or similar material as in this way the coil may not only be accurately centered but the tension of such supporting means may be adjusted.

In its simplest form the central pole of the magnet may be square but it is preferred to use a hexagonal or octagonal shape although there may be almost any number of sides having due regard to the size of the central pole, and whilst the number of sides need not be even, a regular even number is more convenient in manufacture, particularly in constructing the coil former no matter whether it be machined from the solid or fabricated from constituent parts. The larger the

size of the loud speaker, the greater will be the number of sides, for example, two ohm to five ohm loud speakers may have a hexagonal central pole whilst ten to fifteen ohm loudspeakers may have an octagonal central pole.

Now in order that the invention may be clearly understood and readily carried into effect, it is hereinafter more fully described with reference to the accompanying drawings, which are given for purposes of illustration only and not of limitation.

In these drawings:—

Figure 1 is a front view of a simple 80 form of coil former and coil, and

Figure 2 is a side view looking on the right hand side of Figure 1;

Figure 3 is a front view of another form of coil former and coil, and

Figure 4 is a side view looking on the right hand side thereof;

Figure 5 is a front view of the central pole of a magnet for use with a coil of the nature of that illustrated in Figures 96 3 and 4, and

Figure 6 is a side view of the central pole of Figure 5;

Figure 7 is a front view of a magnet ring for use with the central pole of 95 Figure 5, and

Figure 8 is a side view of Figure 7;

Figure 9 is a section through part of a loud speaker taken on the line IX—IX of Figure 10;

Figure 10 is a section on the line X—X of Figure 9 looking in the direction of the rise;

Figures 11 and 12 are perspective views of the constituted parts of the coil former 100 incorporated in the loud speaker of Figures 9 and 10, and

Figure 13 is a perspective view of the complete two-part coil former and its coil.

Referring now to the said drawings in 110 which like parts bear like reference numerals, and in particular to Figures 1 and 2 thereof, the coil former illustrated comprises a boss or hub 1, with lightening bore 1', from which radiate alternate long 111 arms 2<sup>1</sup> and short arms 2<sup>2</sup> at regular spacing in the manner of a cart wheel. The arms terminate in laterally extending or bent round end portions 2<sup>3</sup>, 2<sup>4</sup> respectively, on which the coil 3 is wound.

The ends 2<sup>3</sup> of the longer arms 2<sup>1</sup>, which as may be seen in Figure 1 define a hexagon shape, are intended to support the coil and are hereafter referred to as crank ends to distinguish them from the end portions 2<sup>4</sup> of the shorter arms 2<sup>2</sup> which press on the coil 3. These end portions 2<sup>4</sup> are desirably sufficiently resilient to maintain the tension of the coil 3 even on the occurrence of some expansion due to the heat 12

generated when working in a loud speaker. The coil former illustrated may be machined from a solid piece of magnesium or it may be fabricated in aluminium or other light metal by separately fashioning the boss 1 and the arms 2<sup>1</sup>, 2<sup>2</sup> which are connected together as by welding or soldering.

In a modified construction of coil former illustrated in Figures 2 and 3, all the arms 2 are the same length and the coil 3 is wound onto the turned or bent crank end portions of alternate arms so that it has the same hexagonal shape, whereafter the end portions of the other arms are bent to bear on the coil 3. In this embodiment, particularly when the coil former is fabricated, the arms 2 may extend through a ring 4. A ring may also be employed with the form of coil former illustrated in Figures 1 and 2.

The shape of the central pole for use with the coil former of Figures 3 and 4 is illustrated in Figures 5 and 6 wherein the central pole 5 is formed as a hexagon, and a groove 6 extending at least over part of the length of the pole piece is provided at each angle. The crank ends of the arms 2 enter such grooves so that only the coil 3 lies in the magnet gap. To accommodate the ends of the other arms 2, which lie beyond the coil 3, the outer pole or ring 7 of the magnet which, as illustrated in Figures 7 and 8, has its aperture matching the shape of the central pole 5 has grooves 8 provided at the mid-points along its flat faces.

A central pole for use with the coil former of Figures 1 and 2 will be shaped similarly to the pole piece 5 illustrated in Figure 5, except that, as the ends of all the arms 2<sup>1</sup>, 2<sup>2</sup> lie within the coil 3, grooves will also be provided at the mid-points along the flat face of the pole piece 5 to accommodate the ends 2<sup>1</sup> of the alternate shorter arms 2<sup>2</sup> instead of grooves being provided in those faces of the ring 7 of the magnet.

The ring 4, when such is provided, may serve as the attachment to the neck of the cone of a loud speaker by fitting therein and being suitably secured thereto, for example in the manner later described with reference to Figures 9-13. Otherwise, the apex of a truly conical loud speaker cone may be affixed to the boss 1 as by means of a suitable element such as a bolt extending through such apex to engage in the bore 1<sup>1</sup> in the boss 1. The loud speaker cone may be given truly conical shape by providing a light weight, for example metallic conical piece which may be made fast to the sloping wall of a truncated cone or to the neck of an orthodox loud speaker cone and have its

apex secured to the boss 1 of the coil former.

The ends of the arms of the coil formers illustrated in Figures 1 and 2 and 3 and 4 may be provided with insulation as by coating with varnish or by adhering thereto some asbestos paper in order to avoid short-circuiting of the coil 3 when wound thereon. This coil 3 is wound to have the least possible induction and hence is not only formed as a single layer but the turns thereof may be spaced apart or separated by a thread. The return lead extends up the crank end of one of the arms when, if necessary, the groove in the central pole piece 5 in which that crank end is situated may be slightly enlarged. The coil may also comprise a single turn of metallic ribbon or foil.

Any danger of the radial arms ringing, due to undesired resonance, may be avoided by winding a thread, say of nylon, around each of them or some of them at regular intervals, or by some other such expedient such as coating with varnish or by an application of paper.

Now in Figures 9 and 10 a loud speaker assembly is illustrated which incorporates yet another form of coil former which is formed of two parts which are separately illustrated in Figures 11 and 12 and in Figure 13 when joined together after winding on the coil 3.

This form of coil former is conveniently machined from a solid piece of magnesium and the one member, illustrated in Figure 11, comprises six radial arms 10 terminating in crank ends 11 at right angles thereto, which ends are each insulated by adhering a piece of asbestos paper 12 thereto. A central lightening aperture 13 is formed in the junction of the arms and a ring 14 is also formed integrally with the arms at a convenient distance from the centre. The external diameter of this ring 14 is reduced as at 15 for the purpose which is later made apparent.

The other part of this coil former, illustrated in Figure 12, similarly has six arms 16 radiating from a central portion in which is a bore 13<sup>1</sup> and each arm has an end portion 17. A ring 18, of a diameter matching the smaller external diameter of the ring 14, is similarly formed in this part and the portions of the arms 16 beyond the ring 18 are stepped as at 19.

The coil 3 is wound on to the crank ends 11 of the arms 10 and thereafter the two parts of the coil former are placed together when the smaller overall diameter portion of the ring 14 abuts onto the ring 18 and is centralised by its full diameter portion engaging the stops 19 of

the arms 16, the ends 17 of which bear on the coil 3 intermediate its support by the crank ends 11 of the arms 10.

The two parts of the coil former are held together by nylon thread 21 wound around the arms near the centres and nylon thread 22 may be wound around the arms 10, either beyond the ring 14 as illustrated or within such ring, to prevent ringing of the arms of the coil former.

In this embodiment there are arm ends on each side of the coil, i.e. the crank ends 11 inside and the ends 17 outside the coil 20 so that the central pole of the magnet is shaped as illustrated in Figures 5 and 6 and the ring 7 of the magnet shaped as illustrated in Figures 7 and 8. Thus it will be seen from the upper half of Figure 9 how the crank ends 11 of the arms 10 lie within and work in the grooves 6 in the central pole 5, whilst from the lower half of that Figure how the ends 17 of the arms 16 work in the grooves 8 in the ring 7. It should also be noted that the magnet gap is no wider than sufficient to accommodate the thickness of the coil with adequate clearance.

The ring 18 of the one part of the coil former may, as in the embodiment illustrated, be made fast to the neck 23 of a cone 24 supported by a conventional support spreader 25.

The coil former may be centralised by a spider in the conventional manner, but it is preferred to use a plurality of, say at least three, nylon cords 26, 27, 28 which extend from within the ring 18, through the holes 29 therein, around the arms 16 to pass through a bore in the base of the speaker support 25 to terminate at an adjusting screw 30 or some other convenient form of tensioning means, by means of which the coil former may be centralised with respect to the central pole 5 and held at a tension which may be adjusted.

The coil former last described may be modified either by entirely eliminating the rings 14 and 18 of its two parts or by making such rings no thicker than the arms 10, 16 when the two constituent parts may be held together partly by the nylon cord 21 and partly by the attachment means securing the coil former to the cone, or by the latter means alone which in either case comprises for example a nut and bolt which extends through the central bores 13, 13' to engage the apex of a truly conical cone or of a light conical piece engaging the sloping wall of a truncated cone or the neck 23 of an orthodox cone such as 24 as has already been described with reference to Figures 1 and 2 and 3 and 4.

It should also be noted that the ends 17

of the arms 16 may extend at right angles to such arms, in like manner to the crank ends 11 of the arms 10, instead of being shaped as shown in Figure 12 of the drawings.

It will be appreciated that the coil former may take a great variety of different shapes ranging from the wheel-spoke formation described to a disc having a plurality of flat edges, with or without lightening holes to approximate to the wheel-spoke shape, and having a pin or tongue at each angle extending normal thereto to carry the coil with such pins or tongues working in the grooves in the central pole or partly therein and partly in the ring of the magnet.

In each of the foregoing examples of coil formers, the coil has a hexagonal shape but it may have a shape having fewer or more flats when the number of arms is such as to give the chosen shape and the central pole and plate of the magnet are appropriately shaped to match. A piece of paper of appropriate shape is, preferably, affixed to the arms of the coil former to extend the full size of the central pole, being nicked as necessary to accommodate the end portions of the arms. It is furthermore preferred to place this piece of paper on the side of the coil former facing the central pole as it avoids ringing of the arms.

In every case the coil former functions primarily to transmit the movement of the coil to the loud speaker cone but the arms of the coil former being elastic also provide a degree of resilience to such connection and they also respond or resonate to high frequency movements and such vibration of the arms acting on the cone transmit such high frequency sounds, when the paper or other non-resonant material adhered to the arms may itself be acting as a small high frequency sound transmitting diaphragm.

What I claim is:—

1. A loud speaker in which the central pole is a multi-faced prism having a groove at each angle between adjacent flat surfaces and a light single layer coil is supported in the magnetic gap by the cranked ends of arms radiating from a central hub or boss of lightweight material, which cranked ends work in the grooves in the centre pole while the arms form a resilient connection to the cone.

2. A loud speaker as claimed in Claim 1, in which the coil is damped by further portions or the ends of further arms which bear thereon intermediate the supporting cranked arms, these further portions or arm ends working in grooves in the flat faces of the centre pole or in the outer ring of the magnet.

3. A loud speaker as claimed in Claim 1 or Claim 2, in which the radiating arms extend through or are integral with a ring.
- 5 4. A loud speaker as claimed in any of Claims 1 to 3, in which the hub or boss has a central bore (through which may extend connecting means forming a connection to a truly conical cone or to a
- 10 light cone connected to the loud speaker cone).
5. A loud speaker as claimed in Claims 1 to 4, in which the coil is supported by a two-part coil former, one of which has cranked coil supporting arms and the
- 15 other has the ends of its arms bearing on the coil intermediate the cranked arms.
6. A loud speaker as claimed in any of the preceding Claims, in which a disc of
- 20 paper or other non-resonant material is adhered to the radiating arms, such disc matching the shape of the central pole of the magnet and being nicked to accommodate the cranked ends which support the coil.
7. A loud speaker as claimed in Claim 1, having its coil supported by a coil former substantially as hereinbefore described with reference to Figures 1 and 2, 3 and 4, or 11 to 13 of the accompanying
- 25 drawings.
8. A loud speaker having the cross-section of its central pole as multi-sided figure, with a correspondingly shaped gap in which the coil of like shape is supported, substantially as hereinbefore described with reference to Figures 5 and 6 of the accompanying drawings.
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694,058 COMPLETE SPECIFICATION  
3 SHEETS

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SHEET 1

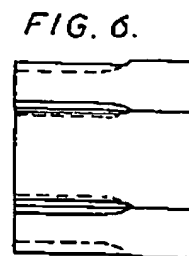
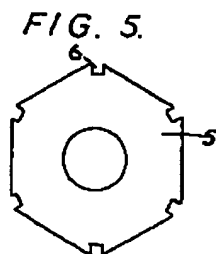
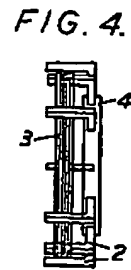
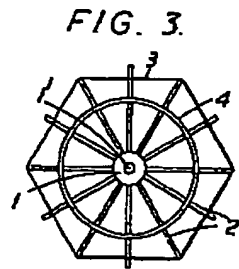
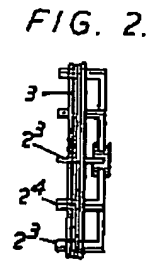
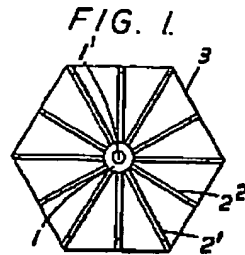


FIG. 7.

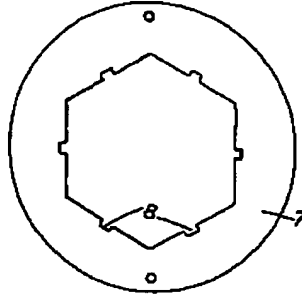
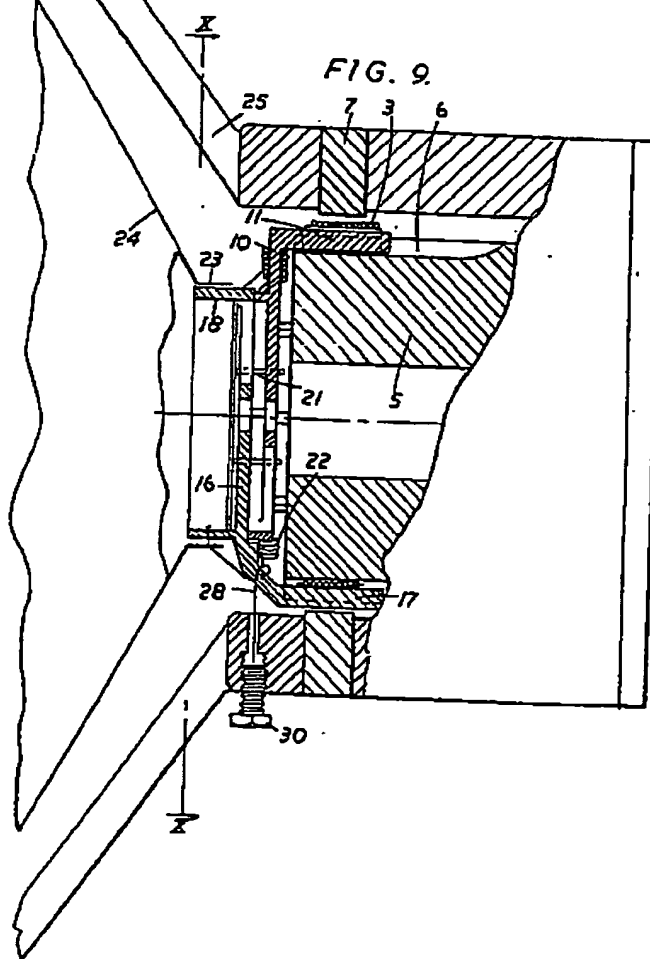


FIG. 8.



FIG. 9.



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3 SHEETS

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the Original on a reduced scale.

SHEETS 2 & 3

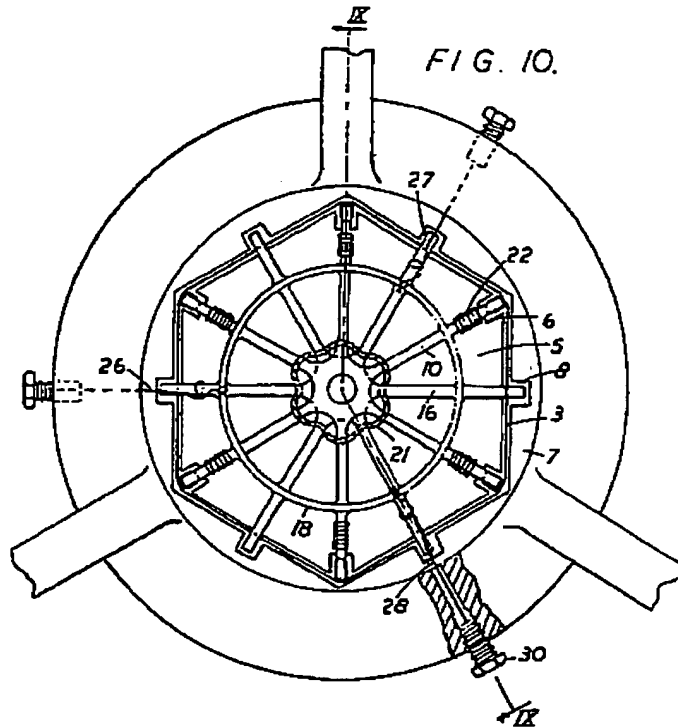


FIG. 11.

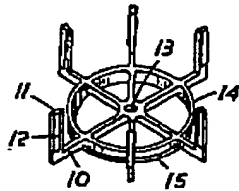


FIG. 13.

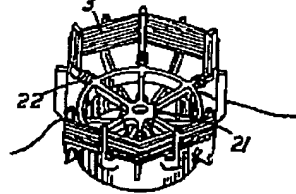
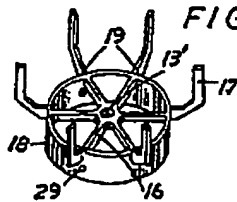


FIG. 12.





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 SHEETS 2 & 3

